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FOOTWEAR FOR INUNDATED AREAS

Douglas S. Swain, et al

Army Natick Laboratories
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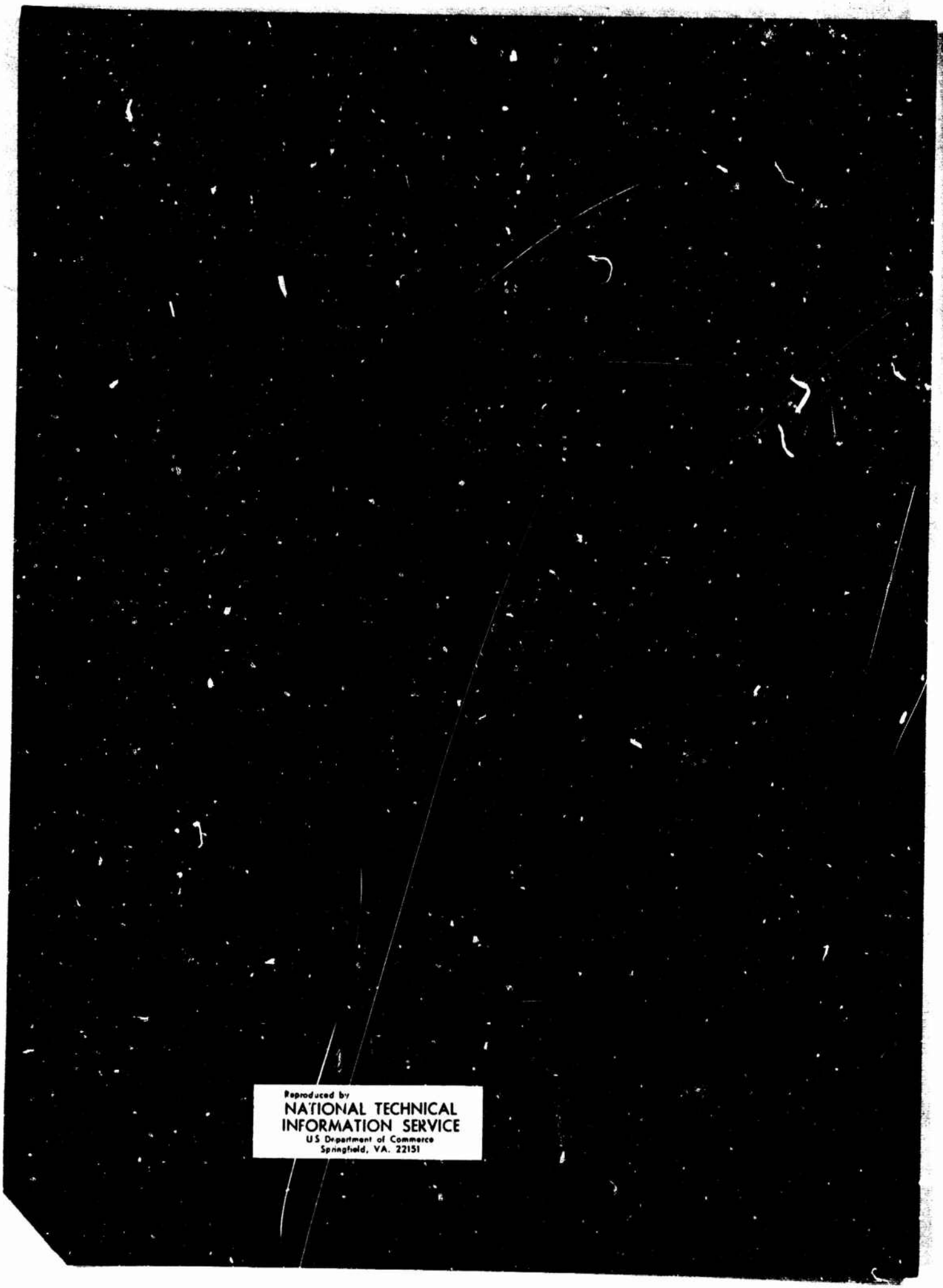

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As a contribution to minimizing the occurrence and intensity of the problem, special footwear was developed by the U.S. Army Natick Laboratories to permit quicker drying of the skin on the feet and legs. These items included a lightweight nylon sock to replace the standard wool sock; a slide fastener for the tropical combat boot to encourage quicker removal of the boots when an opportunity arose to take them off; and a lightweight comfort shoe, similar to a tennis shoe, that could be tucked into a pocket and worn later in bivouac and boot camp areas in place of a soldier's regular boot.

Based upon their successful testing in Vietnam, the above three items were adopted in March 1970 as Standard A items for Zones 1 and 2 (Hot, Tropical Areas).

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FOOTWEAR FOR INUNDATED AREAS

by

Douglas S. Swain and Jeanne F. Spaeth

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FOREWORD

In response to a request from the U. S. Army, stationed in the Republic of Vietnam, the Clothing Branch of the U. S. Army Natick Laboratories developed footwear items to alleviate foot disorders encountered in inundated areas of Southeast Asia.

Acknowledgement for cooperation and assistance in this effort is given to the following: three successive Ninth Infantry Division Surgeons--Lieutenant Colonel Foster Taft, Lieutenant Colonel Travis Blackwell, and Lieutenant Colonel Archibald McFadden; Dr. Harvey Blank and Professor David Taplin of the University of Miami School of Medicine; and Colonel William A. Akers of the Letterman Army Institute of Research.

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ABSTRACT

Warm water immersion foot and related dermatological problems in inundated areas of Southeast Asia seriously limited the combat effectiveness of large numbers of our troops. This problem became the subject of extensive medical study in order to reduce its incidence.

As a contribution to minimizing the occurrence and intensity of the problem, special footwear was developed by the U. S. Army Natick Laboratories to permit quicker drying of the skin on the feet and legs. These items included a lightweight nylon sock to replace the standard wool sock; a slide fastener for the tropical combat boot to encourage quicker removal of the boots when an opportunity arose to take them off; and a lightweight comfort shoe, similar to a tennis shoe, that could be tucked into a pocket and worn later in bivouac and boot camp areas in place of a soldier's regular boot.

Based upon their successful testing in Vietnam, the above three items were adopted in March 1970 as Standard A items for Zones 1 and 2 (Hot, Tropical Areas).

FOOTWEAR FOR INUNDATED AREAS

1. Introduction

In 1967 foot disorders among infantrymen in the swamp areas of Southeast Asia accounted for more man-days-lost than did combat casualties.[1] Foot fungal diseases alone caused an average ineffectiveness rate of 40 percent that year and this rate rose to 55 percent during the hot, wet months of the monsoon season.[2] Contributing to this problem was the standard tropical footwear, which prevented the soldier's skin from drying and kept foot temperatures high. In contrast, local inhabitants wearing sandals and shorts seldom experienced foot disorders.

By June 1969, however, the monthly sick call report showed record low figures for man-days-lost (MDL) due to foot disorders. This report listed weekly averages of 151 MDL (only 1[1] percent of the total man-days-lost) for all combat battalions of the Ninth Infantry Division.[3] One major factor contributing to this sharp decrease was improved footgear.

The development of this new footwear was part of a program initiated in Spring of 1968 by Major General Julian J. Ewell, Commander of the Ninth Infantry Division. This program, entitled Operation Safe Step, had three major goals: 1) institution of broad preventive measures, such as routine foot inspections and improved laundry facilities; 2) medical treatment using newer drugs, including griseofulvin and an anti-fungal solution (Tolnaftate); and 3) tests of new equipment and clothing adaptations. In connection with the latter goal, footwear items were requested through ENSURE* procedures from the U. S. Army Natick Laboratories.

This report will describe the foot disorders encountered by soldiers in the riverine environments of Southeast Asia. Secondly, it will trace the development and testing of new footgear that alleviated these disorders by establishing a system for the proper drying and treatment of feet. This system includes a quick-drying nylon sock, a comfort shoe worn when boots are drying, and a boot with a slide fastener closure allowing speedier removal. Thirdly, this report will record the events leading to the adoption of this system as Standard A for Zones 1 and 2.

*Expediting Non-Standard, Urgent Requirements for Equipment

2. Foot Disorders

Even before any onset of foot disorders caused by bacteria, fungi, or warm water immersion, the combat soldier in Southeast Asia encountered the basic problems of maneuvering in a swampy, jungle terrain and a hot, humid climate. The Mekong Delta, an alluvial plain of 14,000 square miles, contains vast jungles, numerous tributary streams flowing from the Mekong River, and large areas of flooded rice paddies. Mangrove thickets present rough barriers near the seacoast. In heavily cultivated areas, almost 95 percent of the land is inundated during the wet monsoon season, which occurs from mid-June to mid-October with a 6 week transitional period on either side. Approximately 70 percent of the land is under water during the dry season. The resultant mud, thick undergrowth, and streams presented physical hazards to the man on foot and required the protection of sturdy, durable footwear.

Fungal infections, also called dermatophytosis, of the legs and feet were caused principally by two fungi--Trichophyton mentagrophytes and Trichophyton rubrum.[4] These infections produced severe inflammatory lesions and extended over much of the body surface (Figure 1). Early cases involved pruritus and tiny vesicles, often on erythematous, purpuric bases under the boot top area. Men exposed to these fungi frequently suffered from recurring and increasingly severe attacks. A moderate case required 5 days of treatment before the soldier could return to action.

Bacterial disorders, also called pyoderma because of pus formation, required longer treatment period of 8 days and disabled the soldier for 14 to 16 days. These painful infections produced superficial pustular dermatitis and ecthymatous ulcers since both streptococcic and staphylococcic bacteria could be recovered from 90 percent of such skin lesions. Some cases progressed to lymphangitis and fixed brawny edema.

In the above disorders, prolonged water submersion was a contributing and often essential factor in the onset of disease (the attack rate among support troops stationed in day areas was less than 3 percent). In the cases of warm water immersion foot and paddy foot--the two most common foot disorders[5]--prolonged wetness of the skin was the major cause.

Warm water immersion foot involved primarily the soles of the feet and caused the stratum corneum to swell, wrinkle, and turn white. After usually 5 to 7 days of intermittent wetting and drying, the edges and creases of the soles became very tender during normal walking. The feet swelled in the next 24 - 48 hours and the pain increased,

FIGURE 1 - FEET INFECTED WITH DERMATOPHYTOSIS

especially on the soles of the heels and balls of the feet. Soldiers compared walking on their thickened, furrowed stratum corneum to walking on pieces of rope in their boots. If a soldier removed a boot for any reason, he might find it impossible to put it back on because of the pain and edema. This disorder required 7-14 days of treatment, consisting mainly of rest and exposure of the feet to air, before the soldier could return to duty.

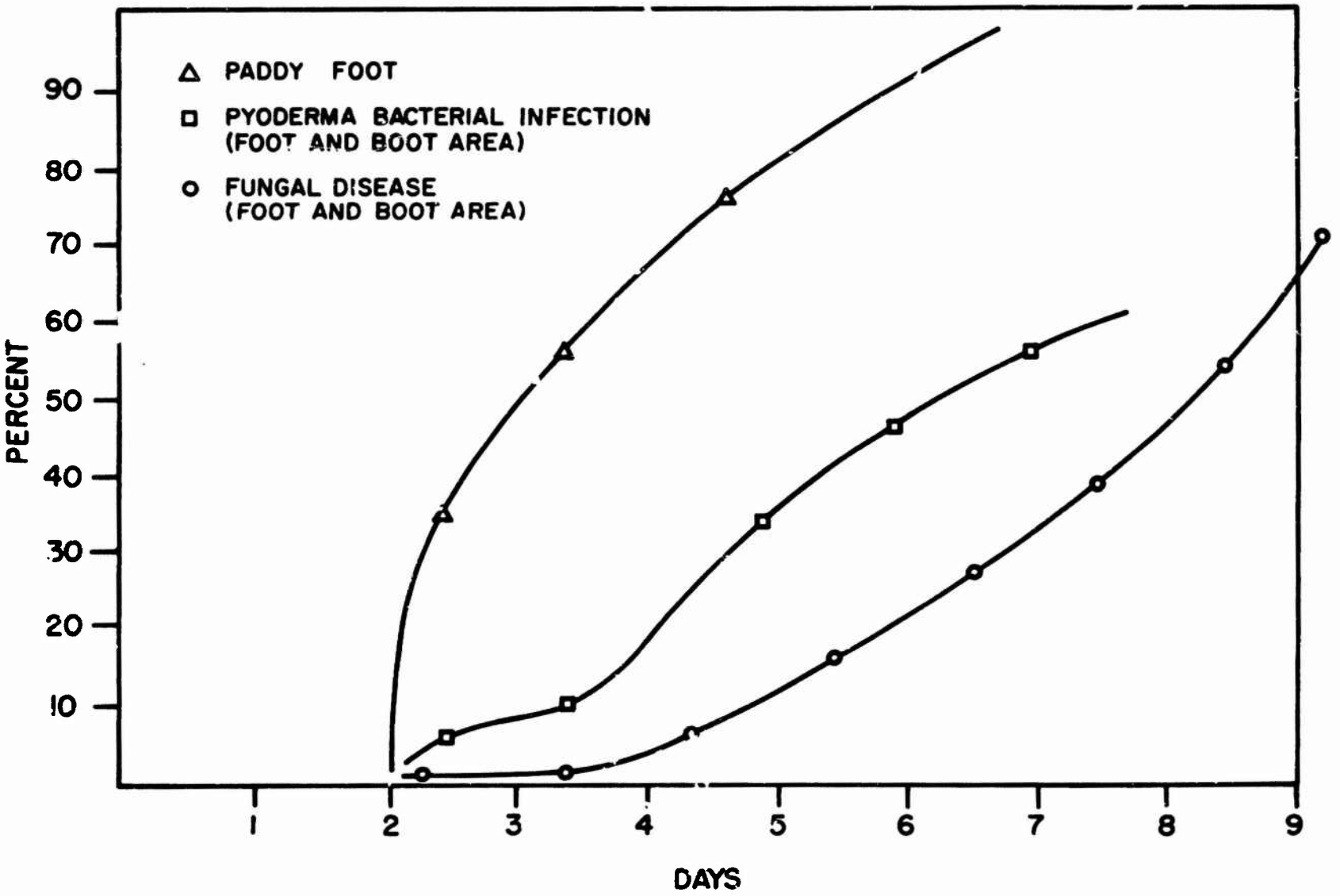
Whereas the usual warm water immersion foot resulted from frequent, intermittent immersion and drying, the second form of water damage, paddy foot, was caused by continous water exposure. It was common among soldiers who continually waded through muddy paddies, streams, and canals. The few times when these men temporarily left the water and mud, heavy mud coatings on the boots prevented drying.

Under the above conditions, in 48 to 60 hours dermatitis appeared over the boot top area, dorsa of the feet, ankles, and legs to the top of the boot and sock. Pruritus under the boot top area began after 18 to 48 hours of wetness. Then, these characteristics developed in the following order: 1) vesicles, 1 to 2 millimeters in diameter; 2) erythema (discrete, patchy, or diffuse); 3) purpura of the vesicle bases; 4) pain on walking; and 5) a hard, brawny, non-pitting edema. In an advanced stage, the soldier was incapable of walking. On the average, 5 days of treatment, involving bed rest and feet elevation, were needed before the soldier could return to action.

In Figure 2, foot disorders are graphically shown in terms of days of immersion and percentage of occurrences. This graph was compiled by Lt. Col. A. W. McFadden from sick call records, weekly health summaries, and military operation summaries of the Ninth Infantry Division.[6]

The graph shows that, after 3 days of constant immersion, 50 percent of the soldiers developed paddy foot (35% of these were noneffective, i.e., unable to walk). After 5 days, 80 percent of the men had paddy foot and were noneffective. The pyoderma bacterial infection curve reveals that 8 percent of the soldiers developed significant pyodermal diseases after 3 days in the paddies; this increased to 20 percent at 4 days, 35 percent 5 days, 45 percent at 5 3/4 days, and 53 percent at 6 3/4 days. Fungal infection produced significant disease in 3 percent of the troops at 4 days, 25 percent at 6 $\frac{1}{2}$ days, and 38 percent at 7 $\frac{1}{2}$ days. Water exposure in the pyoderma cases was less severe because 80 percent of the men would have been casualties from paddy foot after 5 days.

FIGURE 2. INCIDENCE OF FOOT DISORDERS*



*SOURCE:
COL. W. A. AKERS, PADDY FOOT: A WARM WATER IMMERSION FOOT SYNDROME VARIANT (LETTERMAN ARMY INSTITUTE OF RESEARCH: SAN FRANCISCO, CALIFORNIA, 1972)

Thus, it can be concluded from these statistical and medical facts that major preventive measures for foot disorders would be: 1) fast drying footwear with increased aeration and drainage capabilities and 2) avoidance of prolonged warm water immersion, which swells and injures the skin and fosters fungal and bacterial growth.

3. Tests and Evaluations of New Footwear Items

a. Socks

The standard Army sock worn by the soldier in Mekong region was a cushion sole sock composed of 50 percent wool, 30 percent cotton, and 20 percent nylon, and weighing 2.7 ounces (75 g). In wet, swampy areas, this sock had high water retention. Even if removed for short periods, this sock was very slow-drying.

The U.S. Army Natick Laboratories designed two new knee length socks for wear with combat boots (Figure 3). Both types were 50 percent lighter in weight than the standard sock and dried rapidly. The first was a 100 percent nylon stretch sock with an elastic cuff designed to prevent sock slippage from the calf and subsequent bunching. This sock had a cushion sole of terry stitching that provided double thickness for comfort. The second was a mesh knit sock fabricated from a combination yarn of 40 percent cotton twisted with 60 percent stretch nylon. The mesh knit had approximately 50 interstices per square inch (or per 645 square millimeters) which offered more aeration than did the standard sock.

Beginning in Spring, 1969, a series of controlled tests were conducted to compare the standard sock to suggested alternatives. One of the first, directed by Ninth Division Surgeon Lt. Col. McFadden on site in Vietnam, compared the nylon stretch sock to the standard wool sock when both were worn with the standard tropical boot.[7]

The procedure involved six experienced infantry volunteers. Each man wore the experimental nylon stretch sock on one foot and a standard wool sock on the other, with the standard tropical combat boot on both feet. The volunteers marched approximately 8 to 12 hours a day, half of the time through abandoned rice paddies and half of the time on dry terrain; they slept in wet boots at night. Clinical examinations were conducted every 4 to 6 hours. Upon completion of the experiment, examinations were taken and pictorial accounts were made.

FIGURE 3 - NYLON CUSHION SOLE STRETCH SOCK (LEFT) AND NYLON MESH SOCK (RIGHT)

The results showed that all the men but one dropped out after 66, 70, or 74 hours. Three men had developed swelling, erythema, and interdigital erosion with inflammation on the foot with the wool sock. The foot with the nylon stretch sock, however, showed no signs of disease. The overall conclusion was that the nylon stretch sock retarded the progression and severity of foot disease and clearly offered better foot protection than the standard wool sock.

A subsequent test, conducted by Professor David Taplin and Captain Alfred Allen in the Florida Everglades (where water and air temperatures are similar to the Mekong Delta), compared the standard wool sock to the nylon stretch sock when both were worn with an experimental lightweight boot having extra drain holes.[8] The results indicated that the nylon sock was faster drying and remained high on the calf without undue restriction of the leg, even on prolonged marches over wet and rugged terrain. In addition, the nylon sock was easily washed with a bar of soap, squeezed out by hand, and replaced without danger of water-logging the feet. In fact, if swamps were not immediately encountered, the socks dried on the feet within an hour. In contrast, the men wearing the wool sock had only to step into water to be weighted down with damp and abrasive socks for many hours.

In another Everglades test, the nylon/cotton mesh sock was compared to the standard wool sock.[9] Four test participants wore the mesh sock on one foot and the standard sock on the other foot. All participants wore the standard tropical boot. They marched 3 hours in swamps through rough terrain and then 4 hours over dry terrain.

The socks' water absorption was measured after the 3 hours of immersion and then after 1, 2, 3, and 4 hours of drying while the soldiers marched over solid terrain. In every instance, the wool sock absorbed more water than the mesh sock, and the mesh sock dried out faster. Within 2 to 3 hours, the mesh sock was almost dry while the woolen sock contained up to 40 milliliters of water. Another advantage of the mesh sock was that it remained pulled up over the calf even through rapid swamp marching. In contrast, the regular sock frequently slipped down from the calf; often the heel ended up under the arch of the foot or even over the dorsum during marches in water.

Perhaps the most important test was the comparison of the nylon stretch sock to the nylon/cotton mesh sock, both of which had shown advantages over the standard wool sock.[10] This test, conducted by Lt. Col. McFadden in Vietnam, required 11 experienced infantry volunteers to

wear the nylon stretch sock on one foot and the nylon/cotton mesh sock on the other, with the standard tropical boots. As in earlier experiments, the men marched approximately 8 to 12 hours a day, spending half of the time in paddies and half on dry terrain and alternating every 2 hours. The men slept in wet boots at night and were awakened every few hours to submerge their feet in a trough of paddy water and mud. Clinical examinations were conducted every 4 to 6 hours.

The major findings included the following: 1) Seven of the 11 volunteers demonstrated the mesh sock to be inferior to the stretch sock in preventing foot problems. These men developed disorders only in the foot wearing the mesh sock. Four subjects suffered severe interdigital erosions of the foot; two experienced incapacitating blisters; and one developed the immersion foot syndrome. 2) The nylon/cotton mesh sock shredded and rended at points of stress. 3) Overall, the nylon/cotton mesh sock was inferior to the regular stretch sock in preventing foot problems when worn with the standard tropical boot.

Following these controlled tests, the lightweight nylon stretch socks and nylon/cotton mesh socks were issued to troops of the Ninth Division in Vietnam. Colonel William A. Akers, Chief of the Dermatology Research Division, reported findings that confirmed most controlled experiment results: 1) the nylon/cotton mesh socks showed insufficient durability under prolonged field conditions; 2) the nylon stretch sock surpassed the standard wool sock by providing faster drying, less water retention, and better placement (non-sagging); and 3) the stretch sock offered durability, its cushion sole provided comfort, and, although some troops in base camps considered the sock hot, its advantages over the wool sock far outweighed any disadvantages.[11]

Overall, troop acceptance of the stretch sock was high, and the Division requested 500,000 pairs, enough to provide six pairs per man.

b. Comfort Shoe

Another footwear item designed by the U.S. Army Natick Laboratories to alleviate foot disorders was the comfort shoe. A modification of the ordinary sneaker or tennis shoe, it was made for night wear in combat zones and day wear in base camps, where normally boots were worn. The comfort shoe offered extremely light weight, moderate protection, and greater aeration and sunlight exposure than a combat boot.

This lightweight shoe was of blucher design, closing at the backseam and having a one piece vamp and tongue. It was slip last constructed of 9 ounce (260 g) plain weave nylon duck. Its rubber outsole had a fine knurl diamond or chevron design and a thickness of .09 inch (2 mm) at the ball and .15 inch (4 mm) at the heel. Weighing only 6 ounces (170 g), the comfort shoe's outside height measured 4 inches (10 cm) at the heel breast.

Two types of comfort shoe were developed: Type I had a "V" throat design with a three eyelet laced closure, open from the toe to the ankle; and Type II had a closure madeof nylon hook and pile fastener tape (Velcro) on a 2 inch (5 cm) elastic webbing (Figure 4). Although no failure reports of the Type II fastener were ever received, a single eyelet for laces was provided on the blucher construction under the webbing in case it became inoperative.

Each pair of shoes could be folded, put in a plastic, waterproof bag, and placed in the waist pocket of the combat tropical uniform. Since the comfort shoes were so easy to carry, the soldier always had them available for wear when circumstances permitted him to try to dry both his boots and feet.

These experimental shoes were issued in late 1968 to troops of the Ninth Infantry Division. Colonel Akers reported that they were well-accepted by the troops.[12] The men found them easy to put on and carry. In dry areas some troops wore the comfort shoe all day and all night, for the shoes exposed as much skin as possible to the air but protected feet from mud, dirt, rough gravel, and mosquito bites. While the nylon duck retained more body heat and perspiration in daytime wear than a cotton fabric, it offered faster drying qualities than cotton. In combat areas, some battalions were directed to remove their boot and socks and wear the comfort shoes at night, while their wet socks were wrapped around their helmets to dry.

FIGURE 4 - COMFORT SHOE: TYPE I (LEFT) AND TYPE II (RIGHT)

Overall, the Type II shoe proved more popular, since the hook and pile fastener tape closure could be quickly adjusted for individual comfort and allowed rapid placement and removal of shoes. Following the favorable troop acceptance of the comfort shoe, the Ninth Infantry Division requested 80,000 pairs of the Type II shoe.

c. Boots

In 1968 the standard tropical combat boot was made of leather with the exception of cotton/nylon duck quarters and gusset. It had a direct molded sole with a Panama tread design that greatly reduced adhesion of mud and debris. A spike resistant steel shank, incorporated in the insole, protected the soldier from the spikes and punji sticks often encountered in the jungles of Southeast Asia. Two screened drainage eyelets on the inner side of the boot allowed for some drainage of water. Overall, the standard tropical combat boot offered the soldier protection and mobility; however, its high water retention, despite eyelets, proved a problem and fostered the development of fungal, bacterial, and water immersion disorders.

The following controlled experiments and field tests were conducted to determine if new boot materials could help solve the problem of foot disorders.

In June 1968, new boots with fabric rather than leather uppers, or with additional drainage eyelets, were subjected to *in vitro* studies of permeability and draining characteristics.[13] The NLABS developed experimental boots included: a nylon mesh upper boot, a 4 ounce (110 g) nomex upper boot, an 8 ounce (230 g) nomex upper boot, a 9 ounce (260 g) nylon duck upper boot, and jungle boots with numerous drainage holes.

Measurement of water retention after immersion indicated that, except for the nylon mesh boot, the drying rates of the various boots were approximately the same. The key observation was that certain boots absorb less water to begin with and, thus, at any point in time following immersion are drier than the more absorbent boots. The more absorbent boots were generally those with leather in the uppers; the leather jungle boots with numerous drainage holes absorbed the most water and were heaviest. The least absorbent boot was the nylon mesh, with the 4 ounce (110 g) nomex a close second.

In another test conducted in August 1968 in the Ninth Infantry Division research facilities at Dong Tam Base, test participants wore the standard boot on one foot and one of five experimental boots on the other.[14] All the men wore 100 percent nylon stretch socks. The experimental boots were: 1) open mesh nylon; 2) porous mesh nylon; 3) finely woven 9 ounce (260 g) nylon; 4) lightweight nomex; and 5) heavyweight nomex. All of these items had fabric uppers with only the toe cap and lacing band made of leather.

The volunteers marched 6 to 8 kilometers a day in a simulated combat zone. Their feet were kept wet at night by immersion in water.

The results, based on medical inspection, clinical tests, and subjects' comments, were: 1) diseases common to prolonged exposure to a tropical inundated environment were not decreased by these experimental boots; 2) the tightly woven heavyweight nomex boot was subjectively preferred by the volunteers over the standard tropical boot; and 3) the open weave nylon and porous weave nylon boots were unacceptable as combat boots due to discomfort, penetration of foreign matter, susceptibility of wearers' feet to minor trauma, and lack of support and durability. Thus, despite their minimal absorption characteristics, nylon open weave or nylon mesh boots appeared unacceptable as combat boots due to their poor stability.

The inadequacy of nylon mesh was confirmed by a second test conducted in the Everglades.[15] Test participants wore a standard tropical combat boot on one foot and, on the other foot, a boot having a standard rubber spike-resistant sole but uppers, quarters, and tongue of nylon mesh. Standard wool socks were worn.

The men walked 3 hours in swamp water, varying from ankle to thigh depth; the final 30 minutes were covered as fast as possible in water over rough terrain.

Results indicated: 1) feet remained comfortably cooler in the new boot; but 2) even though socks in the new boot dried more quickly, the footwear showed greater increase in net weight due to dirt and grime accumulation in the sock and insole. This accumulation was six times greater in the new boot than the old and caused erosion of the skin. Thus, even though the new boot allowed the foot to dry more rapidly, it offered inadequate protection from insect bites, silt, grit and brush.

Boots of lightweight nomex, which was sturdier than the nylon mesh, were tested in Vietnam field tests in June of 1969. However, results indicated that the nomex was non-supportive compared to the standard nylon/cotton duck canvas.[16]

Field tests of the Taplin boot at about the same time offered no firm conclusion. The Taplin boot--a boot of 7 ounce (200 g) nomex material, Panama sole, and fiberglass rather than leather heel counter and toe cap--offered potential for faster drying and better drainage than the standard boot. However, by the time the boots arrived in South Vietnam, most of the Ninth Infantry Division operating in the Delta area had been transferred back to the States. As a result, the items were tested in the highlands area of Vietnam. This area is relatively dry as opposed to the Delta area for which the boots were originally designed. Due probably to this change in terrain, many of the boots failed--the outsole separated from the toe portion of the boot. Consequently, the test was terminated after a few weeks of wear. NLABS was unable to recover any of the boots to study and determine the cause of failure because the boots were ordered destroyed.

Since changes in basic boot materials were offering no substantial solutions to problems of foot disorders, attention turned to methods for easier and quicker removal of boots. Such methods could encourage drying of the feet and allow for treatment, such as the application of medications.

The main method developed by NLABS to meet this goal was a lightweight slide fastener closure system that could be laced into the standard tropical combat boot (Figure 5). The slide fastener (commonly known as a zipper) was made of nylon filament with nylon stops and a zinc locking slider. It was stitched to a reinforcement tape composed of cotton warp and nylon filling. Incorporated in the reinforcement tape were aluminum eyelets that allowed the slide fastener to be laced into the standard combat boot. Besides affording lightweight and fast drying properties, this system offered the soldier a tremendous savings in time. Whereas a pair of standard boots with conventional laces required an average time of 2 minutes for placement on the feet, a pair of standard boots with the lace-in slide fastener required less than 10 seconds for placement.[17]

In an informal February 1969 field test, men marched over Vietnam terrain in standard and experimental boots, all having the lace-in slide fastener. Although some experimental lightweight nylon boots tore, the slide fastener proved sturdy.[18]

FIGURE 5 - LACE-IN SLIDE FASTENER CLOSURE
WITH STANDARD TROPICAL COMBAT BOOT

During March 1969 at a Vietnam research center, the slide fastener closure was tested with the standard boots and the 100 percent nylon stretch sock.[19] Test volunteers wore the standard boot with the lace-in slide fastener closure on one foot and the standard boot with conventional laces on the other foot, with 100 percent nylon socks on both feet. They marched 8 to 12 hours a day, spending half of the time in paddies and half in dry areas, alternating every 2 hours. The men slept in wet boots at night. Every 4 to 6 hours clinical examinations were conducted.

The results showed that in four of the nine volunteers the boot with the slide fastener closure proved superior in retarding the progression and severity of foot disease. These four men developed foot disorders only in the foot wearing the standard boot with conventional laces. Four men showed no difference in either foot's condition. One man developed foot problems in the foot wearing the slide fastener closure boot. The main conclusion was that the standard boot with the slide fastener closure is, on balance, superior to the standard boot with conventional laces in retarding the development of foot disorders.

In a subsequent field test later that spring by Ninth Infantry Division soldiers on regular duties, the slide fastener closures were used with the standard boots. Reports indicated improved ease of removal and adequate durability. Colonel Akers reported that the slide fastener was "enthusiastically accepted," and the Ninth Division promptly ordered 100,000 slide fasteners.[20]

6. Conclusions

Based on the controlled experiments and field tests, a system for foot care was developed that alleviated foot disorders encountered in inundated areas. This system offered the soldier an easy method for permitting his feet to dry--the prime means of prevention for water immersion disorders and fungal and bacterial diseases fostered by warmth and dampness. At the foundation of this system were the three most successful footwear items developed by NLABS: the cushion sole nylon stretch sock, the slide fastener closure, and the comfort shoe.

First, the cushion sole nylon sock offered half the weight of the standard wool sock, yet provided durability and comfort. Most

importantly, it absorbed far less water than the standard sock, dried faster, and was easier to wash. The soldier could readily wash these socks and dry them overnight by placing them on his helmet. Sagging was eliminated by the elastic cuff and stretch quality of this knee-high sock.

Secondly, the slide fastener closure eliminated the time-consuming lacing of boots. By offering a speedier fastener method, it encouraged soldiers to remove their boots and dry their feet. In addition, the all nylon slide fastener was lightweight and durable. This new closure system was easily and inexpensively available to the troops because it was designed to be laced into the standard tropical combat boot.

Thirdly, the comfort shoe combined with the nylon stretch sock and slide fastener closure to encourage further the removal of boots for foot drying and treatment. This shoe allowed the soldier to expose as much skin as possible to sunlight and air while still maintaining protection from mud, dirt, debris, and insects. A pair of comfort shoes was easily carried by the soldier in his pocket and weighed only 12 ounces (340 g). The hook and pile fastener tape closure permitted speedier placement and removal. In general, the comfort shoe provided a beneficial alternative to the combat boot for day wear in base camps and night wear in combat zones.

The success of this system was evidenced most clearly by the decrease in foot disorders beginning in June 1969. That month a record low of 11 percent of man-days-lost was shown for foot diseases in the Ninth Infantry Division. The new footwear under field test by this Division was a major factor in achieving this decrease.

Official recognition of this system's value in alleviating foot disorders of inundated areas came in March, 1970, when its three components--the nylon sock, slide fastener closure, and comfort shoe--were classified as Standard A for Zones 1 and 2 of the Tropical Area.

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